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PART XVII. VOL. V.

TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

EDITED BY

THE HONORARY SECRETARIES.

SESSION 1865-66.

SOLD AT THE ROOMS OF THE SOCIETY,
36, GEORGE STREET, MANCHESTER.
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PRICE ONE SHILLING.

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TRANSACTIONS

OF THE

MANCHESTER GEOLOGICAL SOCIETY.

No. 17.] VOL. V. [Session 1865-66.

The Monthly Meeting of the Manchester Geological Society was held in the Museum, Peter Street, on Tuesday, June 26th, 1866.

E. W. BINNEY, ESQ., F.R.S., F.G.S., President, in the Chair.

The President said that Mr. John Mackenzie, Mining Engineer, formerly of Wigan, and now of West Maitland, New South Wales, a gentleman well known to many of the members, had sent him some specimens of Cannel Coal (exhibited) from West Hartley, N.S.W., which were stated to be superior to the celebrated Boghead coal. One sample was said to yield 145, and the other 120 gallons of crude oil per ton. In all respects, the samples exhibited so much resembled Boghead coal, both in appearance and streak, as no one could distinguish the one from the other. The New South Wales coal, like the Scotch one, was very variable, soon disappearing and changing into common coal and black stone resembling blackband. As the Scotch deposit would probably soon be exhausted by the great drains made on it for the manufacture of paraffin oil, this discovery was of great importance. The President said that in 1850 he bought Boghead coal at 13s. 6d.

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per ton, and it was now quoted at 80s. In 1843, when he read his paper before this Society, showing that petroleum could be produced from the decomposition, or rather, distillation of peat at a low temperature, little was known either of the origin or utility of this product. In 1848 he (the President) went to Down Holland and showed this deposit to Mr. James Young, and explained how the petroleum was formed. This he did before he accompanied that gentleman down Mr. Oakes' coalpit at Riddings, (Easter, 1849,) and examined the circumstances under which the petroleum occurred there. Since that time it is wonderful to what an extent the manufacture of paraffin oil and the supply of petroleum have reached. Probably no articles of commerce ever made greater strides in the same time. If such had been the case in Scotland and America, no doubt great results would ensue from the discovery of Boghead coal in New South Wales.

In the discussion which ensued,

Mr. Dickinson said he did not think the specimens in any sense distinct from the best Boghead coal. With regard to the last publication of the Society's Transactions, he found some inaccuracies in his reported observations which required correction. He was saying that he had noticed some inferior blackband on the top of the Wigan Four-feet coal, and that he had, in the Scotch blackbands, seen some fossils like those spores which were produced at the meeting. By the way in which this had been condensed, he was made to say that the Scotch people "liked" these fossils in the blackbands. Another point was, that in speaking of the identity of the rocks on this side of the basin and the Oldham side, the word "rocks" was printed "ribs." He understood that a proof of the report had been sent to him, but he never received it.

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The President then referred to the recent successful excursion from Bacup to Todmorden, and which had led to the desire to have another if the necessary arrangements could be made. During the excursion they passed over a bed of rock, which he used to term Gorse Hall rock, above the forty yards coal and just under the flags, containing a calamite. Mr. Aitken was good enough to get a specimen of it and present it to the Society, although Mr. Baldwin first pointed it out. He thought it a very valuable specimen, showing as it did that the calamite was not a distinct plant, but the cast of the pith of a plant, like *Sternbergia* was the pith of *Dadoxylon*.

The following papers were then read—

THE BEST METHODS TO PRODUCE COAL

IN A MARKETABLE CONDITION;

BY

MR. JOHN WARBURTON.

The title given to this paper would suggest the idea that the best methods are here given, but such I do not claim to be the case. It is with a view to a thorough discussion of the subject I chose the above title, and a hope that it may incite us to a searching investigation on this very important topic. True the "exhaustion of the British coal-fields" has been a subject of discussion, and a theme for calculation, at intervals more or less distant, during the last century. Many and various have been the calculations put forth as to the probable duration of our coal-fields, indeed so various that we find them ranging from 100 to 2000 years.

The difference between the extremes certainly is very wide, and to attempt the proof of any of them would result in failure; yet,

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to heedlessly disregard one and all of them would be sheer folly, for we are quite certain, even at the present rate of consumption, that some time or other our coal must be exhausted. With this conviction, it behoves the country, but especially the owners of mineral property, to see to the economisation of this portion of our individual and national wealth. This economisation naturally divides itself into two distinct divisions, first, economy in the production, and second, economy in the consumption.

With the second of these I do not propose to deal, as we have so many smoke consuming inventions, patent fire-grates and stoves, with a host of heat economisers, together with other scientific machines for the economisation of fuel. Notwithstanding all these inventions and appliances, the emissions of our tall chimneys, and the clouds overhanging our streets and villages, indicate clearly enough an imperfection on this side of the question; but this I must leave for some one else, and turn to the first or other side of economising our mineral wealth, and with which we, as its producers, have more especially to do, viz., economisation in the production of coal.

In most things with which we have to do, or require, the stock is kept up, and our wants supplied by a reproduction of those necessaries, as food, raiment, &c. Fortunately or unfortunately, such is not the case with our mineral wealth, for no amount of labour would reproduce a once exhausted seam of coal. This being the case, we are, in duty to future generations, and interest to ourselves and successors, bound to produce all and every part we attempt in the most cleanly and valuable condition possible. I may be considered bold, when I say that a large portion of our coal is not cleanly worked, nor is that that is worked or got, in a very many instances, produced in the most valuable condition.

The methods of working coal are almost as numerous as the mining districts of the country; it follows then, that either the

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requirements of the different districts render it necessary, or that some of our systems are not as good as others, or that we think the system in which we were initiated the best. This, I think, is the most likely, as no method seems to us so good as the one with which we are most acquainted, and have imbibed in our earliest mining experience, hence we find people from the north coming to Lancashire and Yorkshire, and introducing northern systems; Lancashire and Yorkshire men carrying their systems to North and South Wales; and, as a rule, men leaving the place of their initiation, carry and introduce that they already know, for, as a matter of course, that that they know is right, and the unknown *may* be wrong. From this, I think, arises the diversity of opinion, more than the conviction of the merits of one system over another.

In order to better understand our subject, let us suppose a lease of 300 acres of a seam of coal 5 feet thick, with its downcast and upcast shafts, together with all necessary plant for working it. We calculate the quantity of coal to be about 2,250,000 tons, but in practice we should not venture to say more than 1,800,000 tons, deducting a clear one-fifth for waste and pillars, thus taking from the 300, sixty acres, or 450,000 tons. A still further deduction do some of our leaders give, for in March, 1860, in a communication to the *Times*, we have Professor Ansted (criticising Mr. Vivian's calculations), saying that not only one-third, which Mr. Vivian had deducted, but two-thirds should be taken off. Suppose we proceed with these calculations on the 300 acres; according to the Professor we have 750,000 Mr. Vivian 1,500,000, common practice 1,800,000 tons getable, while in the bed we know there exists 2,250,000 tons.

Whichever of these calculations we accept as the nearest approximation to facts, it must be humiliating, and by no means is it creditable to the mining profession. Whilst in these calculations—let us put them in a more tangible form—we prove the coal to exist as before stated, amounting to 2,250,000 tons, supposing all this could be got in a marketable condition, and on the whole

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would clear for interest and redemption 1s. 6d. per ton, it would amount to £168,750; one-third got, £56,250; two-thirds, £112,500; four-fifths, £135,000, making a difference respectively of £112,500, £56,250, and £33,750, the least of which is a formidable item, £33,750 in only 300 acres. This loss, in some cases, as coal is let in Lancashire, Yorkshire, and the Midland Counties, would all be borne by the lessee, in some places as South Wales, &c., the loss would be sustained by the lessee, and an additional loss by the lessor.

These calculations, we admit, may not be carried out to the figure, but I think it is possible to produce the coal so as not more than one-tenth need be lost or destroyed. Thus reducing the loss on 2,250,000 tons to 250,000, or equivalent to £16,875, which I am sure is enough to incite our utmost attention to find a remedy and thus avoid this destruction of one of the prime elements of our national wealth. We can look upon it in no other light than a waste of nature's stored bounties.

If there is this loss, which is, by common consent, acknowledged by all connected with mining operations, then, what, if any, are its remedies? The most simple answer would be,—work out the coal in its entirety without destroying or depreciating its value; this at present we are not prepared to do, in the full sense of the term, for we must leave a portion to support the shafts, which has to be cut through in different directions, thus necessarily reducing its value; but I do say, after a sufficient support is left for the shafts, there need be little or no more ungotten coal, and what is gotten ought to be worked in such a manner as to reduce the waste to a minimum.

What we mean by waste generally is that portion of the coal we *make* unmarketable by cutting it to a powder, and thus render unfit for commercial purposes. Of this, Mr. Bassett, of Cardiff, says there is as much as 35 per cent. Mr. Warrington, of Castleford, says, he has seen a case where 34 per cent. was thus wasted;

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if to this waste we add the amount left, by way of pillars, in some mines the percentage of waste becomes something approaching Professor Ansted's calculations.

The coal and other things being equal, the percentage of waste is highest in localities where "Pillar and Stall" or "Pillar and Benk" forms the system of working. On this system, of necessity a good deal of coal is cut out in "strait" or "narrow" work, which always *does* produce a large proportion of small coal. This is inevitable, for whenever and wherever a miner's pick comes in contact with the coal it is with the object of cutting or disseveringit. (Indeed it strikes me as marvellous that the law of divisability was not discovered by miners, for in no art is its practice more thoroughly developed.) The more of strait work there is cut out, it must follow as a consequence that more small coal will be made, or, in other words, more of the coal will be made small.*

Take, for instance, a strait place 8 ft. wide, in a 5 ft. seam, let the miner prepare 3 ft. for getting out, and you have $5 \times 8 \times 3 = 120$ cubic feet. Ere the piece is got out, one foot of an average at each side must be cut out, or one side cut out and the other blasted, which, in point of producing small, is equal to both sides being cut. Then the coal must be "holed," or "kirved," or "bared" a foot high of an average. Out of the 120 cubic feet you cut $5 \times 3 + 5 \times 3 + 8 \times 3 = 54$ feet; $120 - 54 = 66$ of solid coal; but this has another operation to undergo, which, under favourable circumstances, will raise the small coal into full 55 per cent. It must be evident then the less of cutting there is the better will it be for the production of marketable coal.

In this cutting of coal there is another very heavy drawback; it is considered *the* most laborious work in a colliery, and the men who do this kind of work are the cream of the miners; hence it

* See the amount of strait work in plan of a Yorkshire Colliery.

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comes under what our economists call *skilled* labour, and as such requires extra pay for its performance. Thus we have it as the phrase is, "cutting both ways:" cutting it into valueless rubbish, and paying extra for it. We may carry it still further, a point very commonly lost sight of. All this small coal has to be handled by the men, that is, it has to pass through all the processes of loading, wagoning, drawing, banking, and all the rest of it, as much as good marketable coal. We are aware that in some places small coal is sent up very little nominally, but the full value of the labour *is*, and must be paid for, directly or indirectly; and if the small is left in the pit, all the labour the collier would have to do if sent out has still to be done, and, as a matter of course, must be paid for. The miner's labour is his capital, and he must be paid for the use of it, whether it is employed in producing valueless or profitable coal. Cutting coal then is an expensive operation without a corresponding increase in its value; contrary to most other operations, its expensiveness depreciates its value. Notwithstanding all this, there are many systems requiring so much cutting, still worked, that it makes one almost decide there must either be a counter advantage, or we are careless to look into the matter, or else our mines are so profitable as not to force our attention to the best means of extracting their contents in the most valuable condition.

Take, for instance, a few plans of the present systems, representing Lancashire, Yorkshire, Derbyshire, and South Wales. See how the two former and South Wales are cut in pieces and sections, dreadfully mutilating the coal; yet all this cutting and inter-cutting does not represent the total of the waste on that system, for a great deal of these cuttings, or roads, are in the same direction as the cleavage, that is, technically, the face, board, or slines of the coal exposed or parallel with cuttings, consequently we find the least pressure acting upon the slides divides the coal at the line of cleavage, which, in many cases, is so thin as the pieces so divided break and crumble to powder by

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the mere turning over; and this kind of cleavage will proceed from the side of a road, sometimes four or six yards into the solid on each side of the road.

Thus, first of all, by an actual expensive operation, diminishing the value, and then a greater diminution as a consequence of the exposure of the line of cleavage, this being the case, which few will dispute, what an amount of waste must thus be made in those districts where this system of opening out is *the* system! And strange to say, this *is* the system in the largest coal districts in England, as Lancashire, the North of England, Yorkshire, North and South Wales. And not only in opening-out is the line of cleavage exposed, but in all the workings, or the faces, or heads, or stalls the coal is wrought with the line of cleavage, unprotected or open, and when the pressure or weight acts on the face, which it constantly does, the coal is crushed to dust.

I am not at all surprised that this should have been the primitive mode of getting coal, nor am I surprised that it is so much clung to by the miners of the present day, because the coal, on this system, is dislodged with such comparative ease.

When we look at all these roads with the waste in opening them, then the waste with the pressure on them, and the waste by the constant pressure on the face of the workings, it is no difficult matter to see that full 35 per cent. of the coal so worked is rendered commercially valueless. As a rule commerce rides rampant over old customs and habits, but, in this case, ease and habit take the lead, and consume a large percentage of the real value ere it finds its way into the ledger.

Revert for a moment or two to the roads or openings cut at right angles to the line of cleavage, or those where the end of the coal is exposed, you will find the pressure has not had the same effect, simply because the weight or pressure acts at right angles to the

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line of cleavage, thus the coal is sufficient to resist the pressure, or, if not in all cases, there being no natural cleavage, the coal breaks off in good square merchantable blocks. In this case then we take away one of the evils, namely: that of exposing the line of cleavage; but we have committed one, "that of cutting the roads," which, whether cut on end or face, *must* destroy a portion of coal.

If these statements are correct, which my experience and observation convince me is the case, what we have to do then is, to remove as many of these destroying agencies as we practically can, namely, cutting the coal, exposing the line of cleavage, and working with the line of cleavage constantly exposed. To leave out all these as a plan or system of working coal is by no means novel, for, in the Midland Counties, and here and there a place besides, the system of working is such as very nearly avoids all these points we have named, as most destructive of our mineral wealth.

I agree in the fullest extent with Mr. Vivian, M.P., who, on this question, in the House of Commons, on the 12th inst., said, "Some systems of working coal were far more economical than others; the 'Pillar' system being, in his opinion, the most wasteful."

I would say then in all seams, the quality of which being suitable for export or domestic trade, do no *cutting*, and work the coal with the end exposed, so that all the weight or pressure will act at right angles to the natural cleavage. Do not "hole" or "kirve" in the coal, but in some underlying strata, or intervening, or even overlying bed of unsaleable material. In some parts of the country a "holing clunch" is looked upon as a necessary accompaniment; hence a miner once said to me, "If coal is of vegetable origin, how is it there is always a 'holing' dirt with every seam?" His idea of it was perhaps the most rational, being, that the coal was put there for our use, and the dirt accompanying it so as to enable us to get the coal.

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To work the coal as described would increase the cost of getting it probably some 10 per cent., but as a set off against this you produce the coal in a much more valuable condition, which very likely will be worth 50 per cent. more. There are certain seams of coal I would not incur the extra 10 per cent. in getting; for instance, such as are suitable in quality only for manufacturing purposes, gas coal, or coal, the small of which will make a superior coke, these and inferior coals of course would be best worked to suit their merchantable value; but, with these exceptions, I would work every seam of good coal on the entire "long wall" system, and the working face at right-angles to the line of cleavage, and hole in some accompanying strata. By these means properly carried out, I assert and maintain, the waste, so much complained of, may be reduced from 35 per cent. to 10 per cent.

Having laid these suggestions before you in a practical form, I leave them for your thought, with a hope that a healthful discussion may result in the adoption of some system that will remove from our shoulders the blame justly attributed to us, of wasting our national wealth.

A vote of thanks was passed to Mr. Warburton for his valuable paper.

A long discussion ensued, in the course of which,—

The President remarked that Mr. Warburton had been a considerable portion of his life a working collier, that he had worked in various parts, and under various systems, and that, therefore, his opinion on the practical point at issue was entitled to great consideration.

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Mr. Dickinson said it was evident from the paper that Mr. Warburton knew something of the subject. Many of the points touched upon he had over and over again been preaching throughout that district, but he should be sorry to think that the "Plan of a Lancashire Mine," exhibited by Mr. Warburton, was a fair specimen of what they could do in that county. It was apparently taken from some published report—indeed one of his own contained something very like it, but he did not mention it from the well-doing of that colliery, but to explain how a serious explosion had occurred. The South Wales plan was a very villanous specimen of a coal mine. The stalls were not parallel, and the pillars were all sorts of thicknesses. The coal itself in South Wales, being naturally of a tender kind, got crushed to pieces, and there was under the system shown fully a waste of 35 per cent. The Yorkshire system, as shown in Mr. Warburton's plan, was scarcely a fair specimen of the best mines, where the bank system was generally adopted. No doubt as little "strait" work as possible should be done in a colliery, and that little just when it was wanted. There was no system, in his opinion, equal to the "long wall," as adopted in some of the Midland Counties and in Scotland.

Mr. Knowles asked if the "long wall" system was equally applicable to every kind of mine.

Mr. Dickinson replied that a modified system between the "pillar" and "long wall" suited the Lancashire seams better than any other.

Mr. Warburton said there had been cases where the "long wall" system had been introduced in collieries and failed, but when again tried by those who were determined to succeed, the results had been all that could be desired. It was generally agreed that the real difficulty was in getting a fair trial for the "long wall" system, the colliers being much opposed to it, as they got the coal more easily in other ways.

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Mr. Andrew Knowles said he had been to a number of collieries where they worked on the "long-wall" system, and where they appeared to work very well, getting their coal in good condition; but he did not think the system universally applicable. In connection with mines, there were a great many circumstances which regulated the manner of working. In the north of England they had worked on the "pillar and stall" system, and they might have been necessitated to do it, because of the peculiarity that they wanted coal there in very uncertain quantities, sometimes urgently, at others quietly, according to the state of trade, which is almost entirely dependent upon shipping. They had to work on a system which caused the greatest amount of coal to be exposed for the men to work at during the time the coal was most wanted. He thought it very likely that each district was in the same way governed by certain circumstances which determined the precise mode of working. Their own firm had tried every kind of plan, and they now followed what he called a modified "long wall" system, and they did not find that there was a waste of 10 per cent.—he did not think of 5 per cent. They went into these estimates very closely at times, and showed a fair production of large coal; he thought they obtained as much as possible out of certain mines—at all events, 90 per cent. They only drove a little strait work, and that when it was wanted, but they made a quantity of large coal out of the "strait" work.

The President thought that statement very creditable to them in Lancashire. At the same time he knew of an instance where, out of a 10 feet seam, they were only taking out 4 feet at the top, leaving 6 feet underneath it, and the mining engineer who allowed that waste was a man in high position.

Mr. Dickinson knew of similar instances, but the coal remaining in could be worked hereafter, although it might suffer considerable damage. It was better to leave this 6 feet entire than some 30 or 40 per cent. in pillars.

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The President said it was the general impression that, in the case he had mentioned, the coal would never be worked again.

Mr. Knowles remarked that colliery owners could scarcely be blamed for leaving coal in the ground which would cost more to get than it would fetch in the market. If in some districts they only wanted large coal, and the small could not be profitably procured, he thought owners did right to leave it in the ground. In this district there was a market for all kinds of coal, and very little was wasted. He did not see why any of it should be left in here, and, so far as he knew, it was all swept clean out.

Mr. Livsey inquired what was to be done when there were several feet of soft strata entirely unfit to wall with. He knew a mine where they had a soft roof and a soft floor.

Mr. Warburton had not met with a case of that kind; but he had seen a roof of very soft non-laminated material, and there the road was made by timber, and it stood very well. He had seen 700 yards of continuous road in timber.

Mr. Dickinson said he had seen many "long wall" mines with bad roofs—so bad that, before the men dare attempt "holing," they had first to work little scud holes into the coal and insert roof timber before they dare go underneath it.

After some further discussion,

Mr. Warburton said there was a case which he thought would be of value to the Society to mention. He found from the books of a certain colliery where they worked the "pillar and stall," or bank system, that they made fully one-third of slack. But when the "long wall" system was introduced, and the face of the workings at right angles to the line of cleavage, they only made $\frac{1}{16}$ of slack. The statement in both cases was taken for twelve

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months, from the same pit and same seam, the only alteration that of working the coal.

Mr. Dickinson added that some of the collieries in that county had almost doubled their yield of large coal by altering their system.

ON RECENT EVIDENCES OF

ANCIENT HUMAN HABITATION,

IN POOLE'S CAVERN, BUXTON:

BY MR. JOHN PLANT, F.G.S.

Poole's Cavern is a natural excavation in the carboniferous limestone on the northern slope of Grin Edge, lying about half a mile to the south of Buxton. It has been well known for several hundred years past, having been described by every writer upon the Peak districts of Derbyshire. It extends in a winding direction far into the limestone cliffs, and is a favourite place of resort for the visitors of Buxton.

There exists many records, in the history of the Peak, of bones of extinct elks, deer, and teeth of elephants having been found, partially buried in the stalactites which encrust the rocky floor at various points, and pieces of Roman pottery, Samion-ware, and coins have occasionally been found in the cavern and about its vicinity. The cavern has every appearance of having been originally formed by the passage of a stream of water through a subterranean channel, but this stream of water appears to have diminished greatly and then ceased to flow many years ago, and the channel cannot now be traced either at the entrance or the exit. The entrance to the cavern is contracted, but a little way in it enlarges into a capacious chamber, lined with stalactite, with

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large ones depending from the roof; other lateral chambers and irregularly varying passages continue to the extent of 600 yards, to the head of the cavern.

The floor of the cavern is formed upon the limestone, the middle of it is generally bare, and on the sides are banks of uneven materials, varying from one to nine feet in height. These banks have scarcely ever been disturbed from the time of their first deposition.

In the autumn of last year, the proprietor of Poole's Cavern, Mr. F. Redfern, who is an indefatigable collector and preserver of curiosities found in the cavern and its immediate neighbourhood, thought he would make a "trial" digging into the bank at about 10 yards from the entrance, in the first large chamber, where the bank is fully 8 feet above the limestone floor. The first layer is but a thin covering of decomposing lime and loam lying upon a capping of hard stalactitic matter, averaging about three quarters of an inch thick; underneath this, is a bed of brown clay, having a very small percentage of lime, and averaging about twelve inches thick. Below this clay is another layer of stalactite, not more than a quarter of an inch thick, covering a deeper bed of clay and loam, and this last rests upon a bed of sand and small gravel about 4 feet in thickness. This gravel of irregular thickness is nearly everywhere present, resting upon the limestone; but from the centre pathway in the cavern it is denuded, exposing the uneven surface of the limestone forming the original river bed. In the lowest bed of clay, the excavators exhumed a great number of bones, a few fragments of rude pottery, charcoal, balls of burnt clay, and small stones. The excavation is a limited one, being only 4 feet wide, and yet the quantity of bones found in that small space would indicate the existence of a perfect "*charnel house*" underneath the extensive banks of clay filling both sides of this ancient cave dwelling.

Mr. Redfern has recently been carrying on further excavations, and I have had several opportunities of examining the work and

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the bones and articles already taken from the clay. The greater part of these bones have been broken and cut; they belonged to animals of a domestic kind, such as the cow, sheep, goat, and pig; a few belonged to the deer, goat, and wild boar. At present no recognition of bones of carniverous animals or of extinct species has been made, but the exploration in the clay is too limited, and the examination of the bones but imperfectly accomplished, so that it would be unsafe to rest any conclusions upon negative evidence regarding them, until further and more extensive excavations have been made.

The fragments of rude pottery bear indications as to material, manufacture, and outside markings, which are the recognised characteristics of the pottery of the earliest tribes of people known in Great Britain. The clay, coarse in grain, is moulded by the hand, and is simply ornamented on the outside with crossed lines, scored with a pointed stick;* the clay pot is baked in a charcoal fire, and the fragments show how simple and uniform was the shape of the vessels. A large ribbed bead of earthenware, covered with a green vitreous glaze, was found; it corresponds to the type of beads of early British or Celtic make, but there is an uncertainty about its exact position in the clay. The charcoal is found mixed with the bones, and it is evident these ancient people used the cavern as a dwelling, cooking their food on the bank as the driest part of what must always have been rather a damp habitation, for even now the dripping from the roof and periodical streams from fissures render it uncomfortable. At present neither weapon nor offensive implements of any kind have been discovered; the stones in the gravel are not large enough for weapons, and would not be of much service, even to surround the charcoal fires as hearth stones. There are no traces of rusted iron in the clay, which might be looked for from the decomposition of weapons made of metal.†

* See Sir J. Lubbock, "Pre-Historic Times," fig. 114.

† A small chipped flint, and part of an iron blade have since been found.—August 1st.

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I refrain from expressing any opinion as to the "age of mankind" to which these remains may be referred; the evidences at present are limited enough to judge from, but their direction is consistent and harmonious. The geological aspect is very simple, shewing that the cavern was once a channel for a subterranean river, which left a thick deposit of gravel along its bed; that afterwards the river contracted its volume, but was subject to floods which left the mud and clay on its banks within the cavern, and that during this period the cavern was used by a race of people of primitive and simple habits, but who possessed domesticated animals. That in time the cavern was again vacated, and the dropping from the roof covered the clay with a stalactitic crust. The cavern became again subject to heavy floods of water by which a second bank of clay was deposited and cemented over with stalactites, and from that period no perceptible change has occurred within the cavern.

Mr. Plant illustrated his paper by a section of the deposits at Poole's Cavern, and exhibited several of the bones of animals, and fragments of pottery taken from the clay.

ON THE EXISTENCE OF A

SEA-BEACH ON THE LIMESTONE MOORS,

NEAR BUXTON:

By Mr. John Plant, F.G.S.

During the last three years I have directed my attention to account for the singular characters seen on several spaces of the exposed surface of the carboniferous limestone on the high moors lying about three miles south of Buxton.

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After repeated and careful examination of all the attendant features, I have arrived at the conclusion that they are fine illustrations of "*An Ancient Sea-Beach*," remaining in an almost unaltered condition, from the "post-glacial" period of the submergence of the greater part of the land now forming the British Isles.

The town of Buxton, and the surrounding moors, attain altitudes varying from 1,000 to nearly 2,000 feet above the sea level, the culminating point being Axe Edge on the south-west. That part of the moors lying west and south-west belong to the Yoredale Shales and Millstone Grit formations, and the moors and high valleys to the east and south belong to the Carboniferous limestone.

About one mile to the south of Buxton rises Grin Edge, a long range of limestone running north-west and south-east; it rests in the middle of a broad valley formed by Axe Edge, Burbage Edge, Long Hill, and Black Edge on the west and north, and by lower hills on the east and south, one of which is Harper Hill. The slopes of these hills form the collecting ground for small rivulets, which fall into the river Wye, near Buxton.

The highest point, called "The Tower," on Grin Edge, is 1,435 feet above the sea level, and the top of Harper Hill has nearly a similar elevation. The two are separated by a small valley, the distance from the highest points between these two places being a mile and a quarter as the crow flies.

The north-western slope of Grin Edge and Harper Hill have been scarped into great cliffs by the extensive quarrying of the limestone carried on during many years, and the faces of these cliffs present a grand illustration of the enormous depth of these beds of limestone, the dip of the strata, the cracks, fissures and joints, which everywhere prevail, and abundant specimens of encrinites, corals, and shells are to be found in them, although not so

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finely preserved as in the lower beds of limestone upon which the town of Buxton stands.

In carrying on the quarrying operations, it is usually the present practice first to remove the green turf and thin layer of loam and clay which cover the higher ground of the limestone hills, partly because this clay is valuable in a country so destitute of drift deposits of sand and clay, and is carefully utilized for plantations and agricultural improvements, and partly to keep the limestone quarried below as free from impurities as possible. It is in the course of this preliminary operation of laying bare the southern slopes not far from the ridge of the hills that the singular character of the limestone sea-beach is exposed, and its extent and rocky "*sea-shore*" features are so finely displayed. The surface of the fixed limestone, that is, not the loose rock and shingle, on the upper slope of the hills, is seen to be worn into rounded, hollowed, and fantastic shapes, tolerably uniform in depth and size, and extending along a regular line upon the slope of these hills. The smoothed hollows between these wave-worn stones are filled with small loose shingled stones, lying as promiscuously strewn about as is the shingle upon any rocky coast of our present shores.

The lowest edge of this shingle and rocky shore generally ends in a line of bold craggy rocks, at the base of which are blocks of rolled stones lying upon a glacis or terrace of limestone, with a surface rough and uneven from deep hollows and wash-holes, such as are always found on rocky shores at a very low tide.

These craggy cliffs and rough rocks on the terrace are repeated at lower levels to the bottom of the valley; *not so the rocky beach and shingle.* The upper edge of this sea-beach has not yet been anywhere exposed by the removal of the turf, but it probably extends nearly to the crown of the hills, and would therefore have an elevation above the valley of about 400 feet, and above the present sea level of 1,435 feet. The length of the sea beach,

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which can now be examined, is about half a mile on Grin Edge, and fully that length on Harper Hill, where it is finely exposed. Standing on the sea beach at the latter place, and looking north-west across the valley towards the long flank of Grin Edge, the levels of the two portions of sea beach are seen to be identically the same above the bold craggy cliffs, and there can be no hesitation in fairly concluding that the eastern flank of these hills will be found marked by the rocky *beach and shingle* whenever the turf and clay are removed.

The turf, soil, and clay, together rarely exceed twelve inches in thickness, covering the worn rocks and shingle of the sea beach; and what is perhaps singular, it is a pure yellowish aluminous clay, free from any grit and stone, with scarcely any perceptible amount of lime in it, very similar to a thin layer of yellow tenacious clay which caps the drift in some parts of Manchester. This clay, however, has found its way low down the joints and cracks in the limestone, and is thus found in pockets of considerable extent as may be seen in the face of the quarries, but it yields neither shells nor fossils of any kind, unless the bones of the larger animals recorded as having been found in fissures filled with this clay are to be considered contemporaneous with its deposition. In the valley the loamy soil and peaty deposits are thicker, and rest upon this yellowish clay.

It is remarkable that there are not to be found any evidences of decomposition from the action of weather and time upon this rocky and shingly beach, the shingle and stones are encased in the clay alone, and scarcely a film of deposit arising from the decomposition of the limestone, if any, has taken place since the sea left the high moors of Derbyshire, can be found. The rocks and stones are smoothed and bleached, the fossil shells and encrinites in them are to be seen and felt as a loose gritty covering, but nowhere are those

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signs of calcareous or marly deposits to be found on this ancient "sea-beach."

The paper was illustrated by a map of the hills south of Buxton, shewing the direction and situation of the "sea-beach," a view and section of the beach on Harper Hill; and Mr. Plant exhibited specimens of the clay and shingle stones taken from both Grin Edge and Harper Hill.

A vote of thanks to Mr. Plant for his interesting papers was agreed to.

In reply to a question from the President,

Mr. Plant stated that the clay found on the sea-beach was a pure aluminous clay, and not at all like the loamy clay found in the cavern. He thought the parting occurred in this valley between the carboniferous limestone of Grin Edge, and the millstone grit of Axe Edge.

The President remarked on the frequency of these sea-beaches in North Lancashire and Westmoreland, and the agencies which had formed them. He thought the action of the sea, the atmosphere, and chemical causes should all be taken into the account. He thought an excursion in that neighbourhood would prove interesting. He mentioned the discovery, by Mr. Prestwich, of sea-beach shells between Macclesfield and Axe Edge,—of *Turritella* and *Purpura*,—and these were found in a bank of sand and clay, 1,150 feet above the sea level, and had been undoubtedly deposited when the sea was there.

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Mr. Dickinson said that in the chalk beds there were quantities of similar matter to that deposited in crevices, extending to a considerable depth; and he also looked upon that as being a simultaneous formation with the chalk; that when the segregation of the particles took place, the chalk went to itself, and these clayey matters went into crevices by themselves, by a process of crystallization, or whatever else it might be called.

Mr. Dickinson said this being the last meeting of the Society, he begged leave to move a vote of thanks to the President, not only for his services on that day, but throughout the session.

The resolution was unanimously adopted.

The President, in returning thanks, said he was much obliged for the vote, and any further service he could render to the Society would be cheerfully given. He had now been a member nearly thirty years, and he hoped for almost the remainder of his life to take an interest in the proceedings of the Society.

The meeting then terminated.

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CONTENTS OF PART XVII. VOL. V.

PAGE.

Ordinary Meeting, June, 1866 255

Paper—Mr. Jno. Warburton—The best methods to produce Coal in a Marketable condition 257

Discussion 265

Paper—Mr. John Plant, F.G.S.—On recent evidences of Ancient Human Habitation in Poole's Cavern, Buxton 269

Paper—Mr. John Plant, F.G.S.—On the existence of a Sea-Beach on the Lime Stone Moors, near Buxton. 272

Discussion 276

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